Canada: National Energy
Board

(Inter-utility electricity trade
review)

National Energy Board

CANADA

Office national de l'énergie

File: 1067-40

2 March 1990

To: All Interested Parties

Re: Inter-Utility Electricity Trade Review

The National Energy Board has been asked by the Minister of Energy, Mines and Resources to review and report on measures that could be taken to: (i) encourage greater interprovincial cooperation between Canada's electrical utilities, and (ii) enable buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes. The Minister's letter asked the Board, in carrying out its review, to encourage and facilitate the involvement of the Canadian public.

The Board is planning to carry out the review along two separate tracks. The first will focus on inter-utility cooperation. The second will address questions relating to wheeling and transmission access.

The first track will culminate in a draft report, prepared by Board staff, which will be made available for comment once it is completed. Work with respect to the second track will begin with a study of the technical issues associated with wheeling and transmission access, and it will be carried out for the Board by <u>Casazza, Schultz and Associates</u>, an independent consulting firm specializing in problems associated with the transmission of electricity. The Casazza Schultz study will also be made available to interested parties for comment when it is completed.

473 Albert St.
Ottawa, Ontario
K1A 0E5

473, rue Albert
Ottawa (Ontario)
K1A 0E5

Telephone/Téléphone: (613)990-3167
Telecopier/Télécopieur: 990-7900
Telex/Télex: 053-3791

In carrying out the research necessary for the study of inter-utility cooperation, the Board will be seeking advice and information from Canada's electrical utilities and other interested parties. A letter seeking this assistance, and providing additional information about the review as a whole, accompanies this notice. While it is addressed primarily to the electrical industry, others who may wish to respond to some or all of the questions raised, or to comment on any other relevant matters, are invited to do so.

Parties intending to make a written submission are requested to notify the Secretary before 26 March 1990. Written submissions should be filed with the Secretary by 12 May 1990. Six copies should be provided.

For further information about the review, contact Martin Warnes at (613) 990-0335.

Yours truly,

Marie Tobin

Marie Tobin
Secretary

Attach.

TRANSLATION FROM THE FRENCH

19 September 1988

Mr. R. Priddle
Chairman
National Energy Board
473 Albert Street
Ottawa, Ontario
K1A 0E5

Dear Mr. Priddle:

In its recent report, Energy and Canadians into the 21st Century, the Energy Options Advisory Committee stated that the Government of Canada has a crucial leadership role to play in eliminating barriers to interprovincial trade. The Committee made two particular suggestions:

- Electrical energy generation should be organized on a cooperative interprovincial scale when economically viable.

- The Government of Canada should articulate the conditions under which one province has a right to access, on a business basis, another province's electricity corridor or electrical grid for the purpose of transmitting electricity to a market not adjacent to the first province.

These suggestions raise a number of difficult practical and jurisdictional questions that must be addressed before the Government of Canada can decide whether it is necessary to take specific policy actions in these areas. Accordingly, under Part II of the National Energy Board Act, I would like the Board to review and report on possible measures that could properly be taken to (i) enhance inter-provincial trade in electricity, (ii) encourage greater cooperating between utilities in systems planning and development, and (iii) enable buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes.

Given the importance of this subject, I believe that all interested parties should be given the opportunity to express their views. I will therefore be writing to my provincial colleagues to ask that they participate in seeking solutions, and I would like the Board to take steps to encourage and facilitate involvement by the Canadian public.

Yours sincerely,

Marcel Masse

File: 1067-40

2 March 1990

Letter to Utilities

As you may know, the National Energy Board has been asked by the Minister of Energy, Mines and Resources to review and report on measures that could be taken to: (i) encourage greater interprovincial cooperation between Canada's electrical utilities, and (ii) enable buyers and sellers of electricity to obtain commercial access to available transmission capacity through intervening provinces for wheeling purposes. (A copy of the Minister's letter is attached for your information.)

In responding to this request, the Board will be proceeding along two tracks. The first will focus on inter-utility cooperation. The second will focus on wheeling and transmission access. The two tracks will be intertwined to some degree, because access to transmission systems for wheeling purposes is an important dimension of inter-utility cooperation.

Work on the wheeling issue will commence with a study of the technical and economic issues associated with transmission access, to be carried out by Casazza, Schultz and Associates. The principals involved in this work are Mr. Allan J. Schultz and Mr. W.H. Winter, and they may be contacting you as their work proceeds. Their study will be made available to interested parties for comment once it has been completed.

The track one study -- on inter-utility cooperation -- will proceed independently of the track two work, at least initially, and the Board anticipates that it will culminate in a report that will be released, in draft form, for public comment. This report will examine the inter-utility cooperation that is already taking place in Canada, opportunities for additional cooperation, the benefits that could derive from further cooperation, and mechanisms that would encourage new cooperative initiatives.

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The purpose of this letter is to seek your help in carrying out the research necessary for the track one study. To give focus to the research effort, Board staff have prepared (i) a short paper entitled *Inter-Utility Cooperation: A Conceptual Framework*, and (ii) a questionnaire designed to elicit information concerning the cooperative arrangements that exist or might exist among any particular group of Canadian utilities. Copies of both are attached with this letter. The Board would be grateful if you could review the paper and then respond to the questionnaire.

The paper and the questionnaire have both been written with a view to focussing on those dimensions of inter-utility cooperation that the Board believes are most important in Canada at the present time. However, the information they seek may not fully describe the totality of, or the complexity of, the cooperative arrangements your organization believes are most significant. If that should be the case, please provide whatever additional information you feel would be helpful to the Board in carrying out its mandate.

The Board recognizes that the questionnaire is complex and that some of the questions it raises may be difficult to answer. It would therefore be helpful if you could nominate a single point of contact who could discuss the study with the Board's project officer before a response is undertaken. This would enable the questions to be refined in such a way as to best suit the circumstances that are particular to each respondent. As well, a single point of contact would facilitate ongoing discussions as the study as a whole progresses.

If you have any questions concerning the study, please refer them to Martin Warnes at (613) 990-0335. Responses to the questionnaire should also be sent to him, at the following address:

Martin Warnes
Electric Power Branch
National Energy Board
473 Albert Street
Ottawa, Ontario
K1A 0E5

The Board's study will be greatly enhanced by your contribution. Responses received by 12 May 1990 would be most appreciated.

Yours sincerely,

ORIGINAL SIGNED BY
R. Priddle
SIGNÉ L'ORIGINAL

R. Priddle

Attach.

Inter-Utility Cooperation: A Conceptual Framework

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Inter-Utility Cooperation: A Conceptual Framework

1. Introduction

The National Energy Board ("the Board") has been asked by the Minister of Energy, Mines and Resources to review and report on measures that will enhance inter-utility trade in electricity. As a preliminary step in carrying out this review, the Board is seeking information with respect to (i) the extent to which inter-utility cooperation in respect of electricity is already being achieved, and (ii) the precise areas in which future cooperation is most likely to be most fruitful.

"Inter-utility[1] trade in electricity" is a large subject, embracing a great many diverse activities and functions. Before information can be sought from interested parties, therefore, it is necessary to define more precisely what is of primary interest to the Board at this time. The purpose of this paper is to carry out this task: to clarify the scope of the Board's study by developing a conceptual framework that will describe those aspects of inter-utility cooperation that the Board intends to focus on at the present time.

2. The Dimensions Of Inter-Utility Cooperation

There are two major difficulties that complicate any attempt to describe how utilities cooperate with one another. The first concerns terminology. Words and phrases used in a certain way by one group of utilities may be used somewhat differently by another group of utilities; there is hence no single "correct" terminology that can be employed in describing inter-utility cooperation. To circumvent this difficulty in the discussion that follows, the most important concepts have been defined as precisely as necessary given the context; thereafter, an effort has been made to use them consistently, even though this may lead to some artificiality in certain cases.

The second difficulty is that there are many different dimensions to inter-utility cooperation. That is, any particular cooperative arrangement can be described in terms of the basic purposes being served, the particular services being offered, the financial parameters, the length of the contract, whether or not wheeling is involved, and so forth. At least eight of these dimensions can be discerned:

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1 For purposes of the Board's study, a "utility" will be defined as any entity that buys or sells electricity across a provincial boundary or across the international boundary.

(1) Inter-utility cooperative arrangements are put in place for several *purposes*, for example to improve the reliability of the cooperating systems or to achieve certain economic benefits.

(2) The arrangements fall into two principal *functional categories* (operations and planning), within which there are numerous functional sub-categories.

(3) They can be bilateral or multilateral, the distinction being important because the latter involves *wheeling*.

(4) The cooperation can take place through a variety of formal or informal *mechanisms*, ranging from informal dealmaking to various kinds of pooling arrangements.

(5) The cooperative arrangements can be for different periods of *time*.

(6) They can involve different *economic terms and conditions*.

(7) They can have important *environmental implications*.

(8) They can vary widely in *geographical extent*.

Each of these dimensions will be discussed below. Before proceeding, however, it is worth noting that while the analysis of inter-utility cooperation into various dimensions and sub-dimensions is useful for descriptive purposes, electrical utilities generally do not think about cooperation in this abstract way. This is because, in reality, the various dimensions are inextricably intertwined. A way to illustrate this is to provide a brief sketch of how inter-utility cooperation in Canada has evolved through time.

Canada's electrical utilities generally started out as isolated systems serving local customers. Cooperation began when they first entered into bilateral interconnection agreements with their immediate in-province neighbours. Intraprovincial cooperation then continued, through corporate mergers, the establishment of provincial crown corporations, and through the evolution of formal and informal pooling mechanisms between separate utility entities. In tandem with the extension of intraprovincial cooperation, interprovincial and international cooperation proceeded as well, through a sequence of bilateral arrangements that led to the emergence of a few large interconnections spanning the continent as a whole. Simultaneously, the growing interdependence of the interconnected systems lead to increasingly formal mechanisms to define and regulate common reliability criteria. As the Canadian grid evolves, further cooperative arrangements -- intraprovincially, interprovincially and internationally -- are likely.

3. THE PURPOSE OF INTER-UTILITY COOPERATION

Electric utilities cooperate with one another for many purposes. For example, they cooperate in a variety of information-sharing programs and in the management of research and development. They also work together extensively to develop the reliability criteria that govern the planning and operation of their interconnected systems, and they plan and operate their systems cooperatively so as to ensure that these criteria are satisfied. Utilities may also cooperate (i) to optimize the development and utilization of resources taking account of such factors as financial costs, environmental impacts, socioeconomic impacts, and security of supply; (ii) to maximize opportunities for international exports; and (iii) to achieve the economies associated with large-scale imports. These latter three goals may be characterized, generically, as "economy" objectives.

It is interesting to note that, while the electrical industry tends to differentiate between cooperation for "reliability" purposes and cooperation for "economy" purposes, in reality the two are inseparable. Conceptually, reliability is embedded within the idea of service, and it is reliable service that utilities seek to provide to their customers at the lowest reasonable cost. Strictly speaking, therefore, reliability cannot be divorced from economy; nevertheless, the distinction is a useful one to maintain, because the kinds of cooperation that take place under the aegis of the North American Electric Reliability Council (NERC) are ones that all member utilities voluntarily adhere to for mutual support and assistance, whereas the various economy arrangements tend to be more discretionary.

The Board's study will not be concerned with the extensive and specific kinds of inter-utility cooperation that has evolved (and which continues to evolve) within NERC to address issues of reliability. Its focus will rather be on the way that cooperation can serve other objectives (which may, as noted above, include certain aspects of reliability).

4. THE FUNCTIONAL DIMENSION

Function is concerned with what utilities actually *do* when they agree to cooperate for a certain purpose. Utilities perform two basic functions: operations and planning. Operations are concerned with optimizing the use of a fixed set of facilities to meet current requirements. Planning is concerned with optimizing the system to meet future needs.

A group of utilities can coordinate their operational functions and integrate their planning functions in a great variety of ways, and a number of these are described below. The examples given are illustrative rather than comprehensive. However, because the functional dimension is critical to clarifying the scope of the Board's study, enough detail has been given to identify the kinds of cooperation that are of most interest.

4.1 Operational Arrangements

Isolated utilities have no alternative but to meet their load requirements by planning and operating their systems in the most economic way possible on a self-sufficient basis. When two or more systems are interconnected, on the other hand, each one potentially has access to a greater number of generating units. This permits the interconnected systems to engage in a variety of mutually beneficial arrangements to the extent that transmission constraints permit. There is a multiplicity of such arrangements, which are typically defined in interconnection agreements and which depend upon the state of the two power networks at any given point in time. Some of the more common ones are described below.

4.1.1 Economy Energy

Economy energy is energy that may be delivered in order to effect savings in generation costs when the receiving party has sufficient capacity and energy to supply its own system demand, including exports. Economy energy from the supplying system is used to displace energy that could otherwise be produced by the receiving system, but at a higher incremental cost. For example, a hydro system that has water in its reservoirs in excess of what it anticipates needing could sell energy to a neighbouring thermal system, displacing fuel that would otherwise have to be burned. Economy energy is generally scheduled hour by hour, subject to transmission constraints, and it is interruptible at any time upon notice. Sufficient notice is given to enable the receiving party to start up its collateral units.

Economy energy may be divided into various sub-categories. For example, hydro systems sometimes distinguish between "secondary energy", which can be stored and sold at the time of maximum economic value -- and "spill energy", which must be sold immediately because reservoirs are filled to capacity. Other distinctions depend on whether the source of the energy supplied is a renewable resource (e.g. hydro) or a non-renewable resource (e.g. coal). In general, different price formula apply to each of these various sub-categories.

4.1.2 Non-Economy Capacity And Energy

Economy energy is generally scheduled hour to hour. Capacity and energy can also be contracted for longer periods ranging from weeks to more than a year. Such capacity and energy is surplus to the requirements and commitments of the seller, and it is used by the buyer to improve the economy and reliability of its system. The types of such longer-term arrangements vary:

- *Scheduled outage capacity and energy* is supplied during a period when the receiving party is experiencing a scheduled outage.

- *Participation capacity and energy* is capacity and associated energy that is continuously available from one or more specific generating units (except when such units are temporarily out of service).

- *System capacity and energy* is continuously available from the supplier's system as a whole.

- *Peaking capacity and energy* is capacity and associated energy sold on the expectation that it will be used at a low capacity factor -- i.e. that it will be called upon only at peak periods.

- *Supplemental energy* is provided to supplement the off-peak generating capability of the receiving party during periods of prolonged energy deficiency. It could be purchased by a hydro system during low water years or by a thermal system during a period when offshore fuel supplies are unavailable.

- *Emergency capacity and energy* is supplied when a system is unable to meet its load as a result of a forced outage. The "emergency" period is usually limited in time by the terms of the interconnection agreement; if an outage extends beyond the agreed upon emergency period, other categories of capacity and energy would be made available if needed.

4.1.3 Management Of Operating Reserves

Utilities maintain operating reserves in order to be able to respond to various contingencies (i.e. losses of major elements of supply). There are several categories of operating reserves. "Ten-minute reserves" must be fully available within ten minutes, and are designed to meet a first contingency. Ten-minute reserves comprise the following: unloaded capacity synchronously connected to the supplier's system ("spinning" reserves), units that can be started and loaded within ten minutes, and load reductions that can be made within ten minutes. "Thirty minute reserves" are additional operating reserves that can be made available within thirty minutes, and are generally held to protect against a second contingency. System operators manage their operating reserves by having regard to the size of their anticipated load, the availability of different kinds of generating units on their own system, transmission bottlenecks, and the capability of their interconnections. The existence of the latter means that cooperating utilities can effect mutual savings in the management of their operating reserves because the consequence of a forced generation outage is an instantaneous increase in energy flows across the ties. In effect, the interconnection acts as a reserve generator.

4.1.4 Maintenance Scheduling

Related to the problem of managing operating reserves is the question of scheduling generating units and transmission lines for maintenance. Two of the key variables that a system operator must consider, in preparing for contingencies, are the units available for service and the state of the transmission network. Maintenance carried out on a coordinated basis by a group of utilities can reduce costs and enhance reliability because the use of inefficient facilities and/or the introduction of temporary reserve reductions can be minimized or eliminated.

4.1.5 Load Frequency Control

In the minute-to-minute operation of a power system, generation must be matched to total load to maintain the frequency of the system and to ensure that actual tie-line flows track as closely as possible the flows scheduled. This task is carried out automatically by the Automatic Generation Control ("AGC") System, which, through feedback control mechanisms, automatically changes the generation at certain generating plants (regulating plants) to maintain frequencies and tie-line flows at the desired levels. Interconnected utilities can perform the AGC tasks individually or in an integrated manner. When one of the utilities does not have enough

regulating units or when its AGC system is not functioning, it can contract with other interconnected utilities to provide this service.

4.2 Planning Arrangements

Electric utilities must ensure: (i) that the total generating capacity on their system plus capacity contracted from other systems is adequate to meet their system peak load plus outside firm commitments, with sufficient reserve margin to provide for both scheduled maintenance and forced outage of units; (ii) that dependable system energy plus contracted energy is adequate to supply system firm energy demands and outside firm commitments; (iii) that their opportunities for selling capacity and energy to external markets have been optimized; and (iv) that the transmission system is adequate to meet the system load reliably.

In considering these objectives, system planners assess a number of factors, including capital costs, social and environmental constraints, the likely future availability and cost of fuel, regulatory risks, and the extent to which the mix of generation is balanced with respect to the size, number, type, and location of the various units on the system. When a group of utilities agree to integrate their planning functions, the range of options available can expand significantly, to the mutual benefit of all the cooperating parties. The principal ways in which planning functions can be integrated are as follows.

4.2.1 Purchase And Sales Agreements

Perhaps the simplest kind of cooperation at the planning level comes about when two utilities agree to enter into a specific purchase/sales agreement. Such agreements fall into at least two different classes: (i) near-term supply-demand balancing, and (ii) long-term purchases.

Because the time between the decision to build a new facility and the date of it coming into operation can be quite long, and because load growth is so uncertain, utilities must continually reassess their *near-term supply-demand balances*. ("Near term" here refers to the period after facility commitments have been made but before the new units come into production.) The objective is always to maintain reserve margins for system reliability purposes while at the same time minimizing total costs. Opportunities for cooperation in supply-demand balancing arise because, even when commitments to build new facilities have been made, there is flexibility to temporarily defer construction when short-term excess capacity exists on neighboring systems. Alternatively, when load growth is unexpectedly strong, cooperation may

be necessary to maintain adequate reserve margins. On the supply side of the equation, sales agreements provide revenue from the excess capacity and energy that sometimes exists when large new facilities first come into operation.

Interconnected utilities, when planning to meet their long-term load requirements, have the option to either build new capacity or buy new capacity. Most choose to build. However, circumstances do arise for utilities to minimize costs by entering into *long-term firm capacity/energy purchase agreements*. Such purchases are not unit specific; the seller basically contracts to supply energy and/or capacity that is then made available from its system as a whole. The seller is thus responsible for providing the necessary generation reserves.

4.2.2 Joint Project Development

Situations may arise when two or more utilities cooperate for purposes of developing a large new generation and transmission system. Such agreements can also involve other considerations, such as the management of reservoirs and a common river system. While joint project agreements can be very complex and can entail a very high degree of inter-linkage between the cooperating systems, the planning functions tend to be confined to the specific project, and the operations are thereafter governed by the terms of the contract. Further integration of the utilities' planning functions is generally not entailed. Project sharing agreements can be for a fixed period of time or for the whole life of the project in question. The power and energy output is only as firm as the unit itself.

4.2.3 Generation Planning

Utilities can integrate their generation planning functions in a number of ways, depending on the characteristics of their respective systems and the extent to which they are prepared to become reliant on generating resources outside of their own franchise areas. At the simplest level, two or more utilities can agree to share planning reserves. Certain more specialized cooperative arrangements become possible if the systems share a common river system, if they are able to take advantage of hydro/thermal or hydro/tidal synergy, or if there is diversity in the times that they experience peak loads. More generally, two or more utilities can fully integrate their generation planning functions by agreeing to develop new facilities according to objective criteria -- i.e. without regard to any parochial considerations respecting where the needed facilities are located. These arrangements are summarized in more detail in the paragraphs that follow.

Reserve sharing is possible no matter what kind of generating capability the interconnected systems have. Utilities maintain reserves in order to enable maintenance to occur, to deal with forced outages of major generating units, and to respond to unexpected increases in load growth. Interconnections allow utilities to share their generation reserves, thus reducing the amount of total reserve that the combined systems must carry. At the planning stage, utilities are able to decide the size and mix of reserves that would be optimal over the long term. In general, the reserve sharing benefits are inversely proportional to the relative size of the cooperating systems. Smaller systems tend to receive relatively more reserve benefits than do larger ones.

Hydro/hydro synergy arises when there are benefits from the joint management of a shared river system. For example, situations may occur where one of the utilities does not have the reservoir capacity to store all of the water available to it at a given point in time. If the rivers in question can be regulated by storage facilities developed on the neighboring system, opportunities for cooperation are possible. The objective is to manage flows and storage in such a way as to maximize benefits to the combined systems.

Hydro/thermal synergy becomes possible when a predominantly hydro system is contiguous with a predominantly thermal system. Hydro-based systems with limited reservoir capacity tend to have energy as the critical criterion to be met in the planning of new facilities. Thermally-based systems, on the other hand, are generally able to produce more energy than they need; for them, capacity is the critical planning criterion. Interconnection of hydro and thermal systems thus provides considerable opportunities for mutual benefits. For example, energy reserve agreements can increase the amount of firm energy that hydro systems can schedule, thereby allowing them to defer new capacity that would otherwise be required or, alternatively, to engage in export arrangements involving products of higher quality and quantity. On the other side of the equation, thermal systems can rely on hydro systems for peaking requirements, and they may also be able to share in the benefits associated with new hydro sites that can be developed at costs lower than the thermal alternatives.

The possibility of *hydro/tidal* synergy arises because of the fact that the times at which tidal systems can deliver large amounts of electrical energy do not generally correspond to the times when such energy is needed. For a large tidal facility to be economic, an energy banking mechanism is required to store the excess energy, and one of the best "banks" might be the reservoir of a neighbouring hydraulic system.

Time diversity arrangements become possible when different utilities determine that their respective peak demand periods come at different times. There are at least three reasons why this kind of diversity might arise. The first is that periods of peak electricity demand are determined by the weather and a host of other variables; statistically, therefore, the time of peak demand will vary from one area to the next. The second reason is that different time zones will result in some east-west diversity in peak periods. The third reason is north-south seasonal diversity: utilities in the north tend to have their peaks in the winter; those in the south have their peaks in the summer. This fact -- that the period of peak demand for one utility is generally not coincident with that of another -- means that savings can be effected through cooperation. Time diversity arrangements can take the form of "equichange", in which capacity and energy delivered by one system are returned at a later date by the receiving system; alternatively, the services may paid for in cash as they are supplied.

Optimization occurs on a cooperative basis when a group of utilities agree (i) to assess all of the generating opportunities available to the group as a whole according to common objective criteria, and then (ii) to order these options according to the criteria stated. When different utilities have access to different resources, different technological specializations, and different siting opportunities, the evaluation procedure is likely to establish a hierarchy indicating the sequence with which the facilities in question should be developed. The effectiveness of this kind of cooperation is a direct function of the extent to which decisions are based on the objective evaluation criteria; the more that parochial considerations play a part, the more likely it is that decisions will yield results that are sub-optimal relative to the other criteria.

4.2.4 Transmission Planning

The joint planning of interconnections is fundamental to all other kinds of inter-utility cooperation, and the benefits of interconnections are widely recognized. Less widely recognized, however, is the fact that groups of interconnected utilities may be able to achieve mutual benefits by integrating their transmission planning more generally. This is because any new transmission system will have implications for every utility within the interconnected network. For example, a given Canadian utility might benefit if one of its Canadian neighbors were to expand its north-south transfer capacity, because such an addition might result in the elimination of an operating constraint (imposed for reliability reasons) on the former utility's own north-south interconnections.

4.2.5 Export Marketing and Import Coordination

Cooperation for planning purposes normally begins within a given region, and many members in a regional partnership may, at the same time, be buying or selling electricity with utilities outside of the region. At some stage in the evolution of the partnership, it may be beneficial to coordinate these external transfer functions. When a given regional partnership is a net buyer from external sellers, savings can be achieved because cooperation enables the several members to make larger purchases and to negotiate as a single unit. When a given regional partnership is a net seller to external markets, cooperation enables the members to raise both the quantity and also the quality of any electricity being sold, thus raising the profitability of the selling transactions.

5. Arrangements Involving Wheeling

The third dimension of inter-utility cooperation concerns the *number* of the cooperating entities. The basic distinction is between arrangements that are bilateral and arrangements that are multilateral. The importance of this distinction is that multilateral cooperation involves *wheeling* in one form or another. Wheeling is the transmission of electricity from one utility, through the transmission network of another utility, for delivery to a third party. Wheeling arrangements permit capacity and energy to be traded over very broad geographic areas. Their essential feature is that intermediate utilities make excess transmission capacity available to other parties, subject to certain conditions, thus enabling sellers to have access to more than one buyer and buyers to have access to more than one seller.

A number of the functional arrangements described in section 4 above, relating to both operations and planning, could involve wheeling. However, wheeling raises a number of issues unique to itself, and it is therefore useful to discuss it separately.

There are different *kinds* of wheeling, and there are different *institutional modes* whereby wheeling can be effected. Fundamentally, there are two basic kinds of wheeling: firm and non-firm. The institutional modes whereby wheeling can be effected fall within three separate classes: back-to-back purchase and sales agreements, energy marketing, and contract wheeling. These several concepts will be described briefly below.

5.1 The Basic Kinds Of Wheeling

5.1.1 Non-Firm Wheeling

Non-firm wheeling agreements tend to be short-term and are unlikely to require the expansion of facilities. They arise mostly in operational contexts, when a utility wants to replace its own high-cost generation with generation purchased from another utility to which it is not interconnected. Such transactions can be interrupted according to conditions specified by the buyer, the seller, or the wheeling entity.

5.1.2 Firm Wheeling

Firm wheeling can arise in either an operational or a planning context, when a buyer or seller is interested in contracting for firm power with another utility with whom it is not interconnected. The wheeling utility in this case is asked to provide a firm transmission path for the duration of a buy-sell contract. The utility requesting the wheeling service specifies the parameters of the service being asked for, including such details as duration, schedule, locations of delivery and receipt, firmness desired, and the level of risk the two initiating parties are prepared to assume. The wheeling utility then typically conducts the necessary power system studies to identify the impact of the requested service upon its system, taking account of its primary obligation to satisfy its own firm commitments at the lowest possible cost. These studies determine whether modifications are needed to the wheeling utility's transmission system to provide the requested service.

5.2 The Institutional Modes Whereby Wheeling Can Be Effected

5.2.1 Back-To-Back Purchase And Sales Agreements

Back-to-back purchase and sales agreements involve separate, but related, buy-sell contracts. The primary active agents are the ultimate buyer and the ultimate seller; they are the ones that initiate the necessary set of contractual arrangements. The intermediaries play a secondary role: they buy and resell the service that the primary agents wish to exchange, without changing the quality of the service in any fundamental way. The intermediaries' profit comes from the difference between the purchase price and the sale price.

5.2.2 Energy Marketing

Energy marketing occurs when the the roles described above are reversed. Energy marketing may be defined as a situation wherein an intermediate utility initiates the bulk of the transactions, buying and selling capacity and energy in such a way that there is no necessary connection between the services bought and the services sold. What happens is that the intermediate utility buys a variety of electricity services, unbundles them, and then rebundles them in the form sought by customers. The rebundling is possible because the intermediary buys a variety of capacity and energy services and then combines these with the capacity and energy available on its own system. It may therefore be debatable whether a utility engaged in such simultaneous buying and selling is, in actual fact, engaged in wheeling. However, wheeling can be said to take place at least to the extent that the intermediary is both a buyer and a seller, even though it may be impossible to identify the specific wheeling service.

5.2.3 Contract Wheeling

The distinctive feature of back-to-back and marketing arrangements is that non-interconnected parties do not deal directly with one another. Contract wheeling occurs when the intermediate parties agree to provide a wheeling service *as such*, thereby enabling non-interconnected buyers and sellers to negotiate directly. The price of the wheeling service could be posted in advance or it could be negotiated on a case-by-case basis.

6. COOPERATIVE MECHANISMS

The fourth dimension of inter-utility cooperation concerns the formal and informal *mechanisms* that utilities put in place to enhance cooperation. Perhaps the best way to describe what is meant here is to begin by considering two limiting cases. At one pole, utilities simply engage in "*ad hoc*" dealmaking with their interconnected neighbours; they do not have a "cooperative mechanism" as such. At the other pole, they merge with one or more other utilities into a single corporate entity, and the cooperative mechanism becomes a unified management structure reporting to a single board of directors. In between these two limits are various kinds of pooling arrangements, in which some functions are fully integrated and others are not; the more that functions are integrated, the "tighter" the pool.

To further specify this particular dimension, four points along the continuum will be described below. While none of these may describe existing cooperative mechanisms perfectly, they should serve to identify the range of possibilities.

6.1 Informal Dealmaking

Informal dealmaking is the most common way in which utilities interact with one another. Each transaction is approached separately, and decisions are taken on a case-by-case basis. The amount of cooperation will vary as circumstances warrant, and at any given time it may be extensive or virtually non-existent. When arrangements are wholly informal, each utility regards itself as a fully independent entity responsible for meeting its own load as economically and as reliably as possible; autonomy with respect to both operations and planning is thus retained to a very high degree.

6.2 Loose Pooling

Loose pooling may be defined as a situation wherein a group of utilities agrees to coordinate their operational functions in some way. The exact mechanism employed could be very informal (e.g. system operators could simply develop, over time, a set of mutually acceptable operating procedures) or very formal (e.g. the pooling entities could establish a central office responsible for implementing a negotiated -- and therefore well-defined -- set of activities).

One of the most effective ways for a group of utilities to establish a loose pool would be for them to centralize their unit commitment and economic dispatch functions, so that decisions as to which generating units will be committed and economically dispatched to serve the combined system load are made from one common operating point. With centralization of the commitment and dispatch functions, wheeling is completely unobstructed and the central operator has all the information necessary to supply energy and capacity requirements at the lowest possible cost consistent with system-wide reliability criteria.

In addition to the above kinds of arrangements, a loose pool could also centralize operational planning functions, including reserve assessments, maintenance scheduling, short-term load forecasting, and the specification of transmission constraints and equipment settings.

6.3 Energy Brokering

The coordination of unit commitment and economic dispatch can be achieved in other ways. In an energy brokering system, for example, a group of utilities establishes a centralized information center to compile buy/sell and wheeling quotes from each participating member. This information is then made available to all, permitting mutually beneficial economic arrangements to be struck wherever it is advantageous to do so. In theory, such a system is as efficient as centralized commitment and dispatch, because, once again, all of the relevant information is available to participants in the pool, and each participating member has an interest in taking advantage of the most economic opportunities available.

6.4 Tight Pooling

A tight pool is a formal arrangement among two or more utilities involving the coordination of operational functions and also the integration of planning functions. The integrated planning that tight pooling entails could evolve out of the operation of a loose pool. The advantages of tight pooling are that a certain amount of duplication can be avoided and a higher degree of optimization can generally be achieved.

6.5 Corporate Merger

In the mechanisms described above, each participating utility retains its individuality and decision-making autonomy. The next logical step after tight pooling is obviously one where the cooperating entities decide to capture all of the possible benefits of cooperation by becoming a single corporate entity. Theoretically, such mergers make sense provided that the economies of scale achieved by full integration are not outweighed by the diseconomies of scale.

7. The Time Dimension

Any given arrangement between utilities will be for a particular period of time, ranging from minutes for certain operational functions to decades for long-term purchase and sales contracts. Generally speaking, operational arrangements will have a shorter duration than planning arrangements, although designations such as "short term" and "long term" could apply to each. (These phrases have no precise meaning except in very specific contexts.) Short-term arrangements, although they receive considerably less attention than large long-term agreements, are no less significant; indeed, because they are reasonably easy to negotiate and permit

considerable functional scope, shorter-term arrangements must be regarded as an important focus for the continued evolution of inter-utility cooperation in Canada.

8. The Economic Dimension

It is obvious that most inter-utility cooperation agreements will define financial terms and conditions describing how the benefits of the arrangement are to be shared. Where the financial parameters themselves are not precisely specified, the agreement is likely to define a process whereby they are to be determined. For example, certain interconnection agreements specify that the rates of payment for certain kinds of transactions are to be negotiated by the relevant operating committee.

The Board's study will not focus on financial parameters as such. However, the Board is seeking to determine the extent to which inter-utility cooperation has led to economic benefits in the past, and the extent to which it could lead to additional benefits in the future. These benefits can be identified in general (qualitative) terms. An important question, which will be addressed to Canada's electrical utilities, is the extent to which the benefits can also be specified quantitatively.

9. The Environmental Dimension

Environmental issues are increasingly becoming relevant to decisions that must be made concerning the sources of new electricity generation and the siting of new generation and transmission systems, and inter-utility cooperation may be able to provide significant benefits to Canada in this regard. For example, cooperation could reduce total capacity requirements. Second, it could result in patterns of electrical energy production that are environmentally preferable to those that would obtain in the absence of cooperation. Third, inter-utility cooperation could permit sources of generation that are environmentally benign to proceed before sources that are less benign. Finally, cooperation could result in transmission lines being built in areas that are less environmentally sensitive than would otherwise be the case. Identification of these and other potential environmental benefits will be an important focus of the Board's study.

10. The Geographic Dimension

Cooperative arrangements between electrical utilities can be intraprovincial (involving utilities within a single province), interprovincial (involving Canadian utilities in more than one province), or international (involving utilities in both Canada and the United States). International arrangements can in turn be divided into two varieties: simple (where there is only one Canadian utility involved) and composite (where there are two or more Canadian utilities involved). Among North American utilities, the geographic extent of inter-utility cooperation tends to depend on the particular function or objective. With respect to reliability, for example, cooperation is extended throughout the continent as a whole. In other respects (e.g. systems planning), cooperation is much more narrowly confined. In Canada, the primary geographic units for purposes of electricity cooperation tend to be defined by provincial boundaries. In the United States, there are no natural units in this sense, and highly coordinated and integrated entities often extend across several states.

As was noted at the outset, the primary focus of the present study is *interprovincial* electricity cooperation. However, it is not possible to describe the full extent to which interprovincial cooperation can evolve in Canada without taking account of international cooperation. As well, experience in respect of intraprovincial cooperation might provide useful lessons for how interprovincial cooperation might develop. For these reasons, the attached questionnaire seeks to elicit information about both interprovincial and international cooperation, and it also asks for information with respect to intraprovincial cooperation to the extent that interested parties believe that such information would be of assistance to the Board.

11. Conclusion

The framework for inter-utility cooperation described in this paper is not the only one that could be developed. Nor are the various functional arrangements and cooperative mechanisms described above comprehensive; other possibilities no doubt could, and perhaps should, be included. Nevertheless, the framework outlined here should be sufficient to describe most of the more significant cooperation possibilities that are prevalent now and that are potentially realizable in the future. The specific questions that the Board would like interested parties to address are set forth in the attached questionnaire.

INTER-UTILITY COOPERATION QUESTIONNAIRE

Interconnections

1. Please fill in the attached table 1, identifying all *existing* interconnections (69 kV and above) that you now have with other utilities in Canada or in the United States. Include intraprovincial interconnections, interprovincial interconnections, and international interconnections.

2. Please fill in the attached table 2, identifying all *potential* new intraprovincial, interprovincial, and international interconnections that could possibly be installed in the 1990-2020 period.

Existing Cooperation Agreements[1]

3. Please identify all of the *existing* inter-utility agreements that you are now a party to. Give the name of the agreement (if any), the names of the other utilities who are a party to the agreement, the date it was entered into, its duration, and its basic purpose. If the agreement is not confidential, please provide the Board with a copy.

4. For each agreement identified in question (3), please identify (i) its relevant functional characteristics (see section 4 of the attached paper entitled *Inter-Utility Cooperation: A Conceptual Framework*), (ii) any wheeling arrangements that the agreement entails (see section 5 of the attached paper), (iii) the particular mechanism of cooperation, if relevant (see section 6 of the attached paper), and (iv) any other considerations you feel are important.

5. For each agreement identified in question (3), please provide, from your own perspective, a qualitative description of (i) the economic benefits that have resulted, (ii) the reliability benefits that have resulted, (iii) the environmental benefits that have resulted, and (iv) any other benefits that have resulted.

6. To the extent feasible, please provide approximate quantitative estimates of the benefits identified in responding to question (5).

Future Cooperation Initiatives[2]

7. Please identify any new cooperation initiatives that you can envisage coming into effect in the 1990-2020 period. Give the names of the parties who would be involved, the purpose of the initiative, the approximate date when it could come into effect, and its likely duration.

8. For each of the proposed initiatives identified in question (7), please identify (i) its relevant functional characteristics (see section 4 of the attached paper), (ii) any wheeling

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[1] In this section and the next, the term "agreement" refers to any accord you may have with other entities engaged in international or interprovincial electricity trade -- whether formal or informal. To the extent that you believe the information would assist the Board, responses relating to *intraprovincial* cooperation agreements would also be appreciated.

[2] In this section, the term "initiative" has the same meaning as "agreement" in the preceding section, except that it refers to future agreements rather than existing ones.

arrangements that the initiative might entail (see section 5 of the attached paper), (iii) the particular mechanism of cooperation, if relevant (see section 6 of the attached paper), and (iv) any other considerations you feel are important.

9. For each of the proposed initiatives identified in question (7), please provide a brief explanation of the conditions (e.g. economic conditions, the situation in external markets, internal demand conditions) that would be necessary to bring the initiative about.

10. For each of the proposed initiatives identified in question (7), please indicate what actions by (i) utilities, (ii) provincial governments, and (iii) the federal government would assist in bringing the initiative about.

11. For each of the proposed initiatives identified in question (7), please indicate, from your own perspective, a qualitative description of (i) the economic benefits that are likely to be achieved, (ii) the reliability benefits that are likely to be achieved, (iii) any environmental benefits that are likely to be achieved, and (iv) any other benefits that are likely to be achieved.

12. To the extent feasible, please provide an approximate quantitative estimate of the benefits identified in responding to question 11.

Additional Questions

13. Please provide two copies of your most recent resource plan.

14. Please provide any comments you feel would be relevant respecting the role that independent power production might have in facilitating interprovincial cooperation in the production of electricity.

TABLE 1: EXISTING INTERCONNECTIONS

NAME OF RESPONDING UTILITY: ______________________

INTERCONNECTION WITH	SUBSTATION TERMINAL LOCATIONS		TYPE(1)	IN SERVICE DATE (YEAR)	OPERATIING VOLTAGE (kV)	DESIGN CAPACITY (2) (MW)	OUTFLOW LIMIT(3) (MW)	INFLOW LIMIT(4) (MW)
	RESPONDING UTILITY	CONNECTED UTILITY						

(1) Indicate whether the interconnection is AC or DC, and add an asterisk (e.g. AC*) if the interconnection has an associated phase-shifting device.

(2) The maximum capacity that the interconnection could sustain before confronting thermal limits.

(3) The maximum capacity that the interconnection could sustain before confronting stability limits, reliability limits, or other operating constraints, in the sending direction.

(4) The maximum capacity that the interconnection could sustain before confronting stability limits, reliability limits, or other operating constraints, in the receiving direction.

TABLE 2: POTENTIAL INTERCONNECTIONS

NAME OF RESPONDING UTILITY:________________________

INTERCONNECTION WITH	SUBSTATION TERMINAL LOCATIONS		TYPE(1)	IN SERVICE DATE (YEAR)	OPERATIING VOLTAGE (kV)	DESIGN CAPACITY (2) (MW)	OUTFLOW LIMIT(3) (MW)	INFLOW LIMIT(4) (MW)
	RESPONDING UTILITY	CONNECTED UTILITY						

(1) Indicate whether the interconnection is AC or DC, and add an asterisk (e.g. AC*) if the interconnection has an associated phase-shifting device.
(2) The maximum capacity that the interconnection could sustain before confronting thermal limits.
(3) The maximum capacity that the interconnection could sustain before confronting stability limits, reliability limits, or other operating constraints, in the sending direction.
(4) The maximum capacity that the interconnection could sustain before confronting stability limits, reliability limits, or other operating constraints, in the receiving direction.